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Taxonomic paper

First description of the worker caste of *Nylanderia smythiesii* (Hymenoptera: Formicidae)

Aijaz Ahmad Wachkoo†, Himender Bharti†

† Punjabi University, Patiala, India

Corresponding author: Aijaz Ahmad Wachkoo (aijaz_shoorida@yahoo.co.in)

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Abstract

The hitherto unknown worker caste of *Nylanderia smythiesii* (Forel, 1894) is described for the first time. Sexuals are redescribed and photomontage images of all castes are provided. A key is presented to separate the six Indian species of *Nylanderia*. Previously described *Nylanderia assimilis* (Jerdon, 1851) is considered a *species inquirenda*.

Keywords

Formicinae, Himalaya, *species inquirenda*, key, ants, taxonomy

Introduction

Based on the taxonomy and molecular phylogeny of *Prenolepis* genus-group LaPolla et al. (2010) raised *Nylanderia*, a formerly synonymized subgenus to generic status. It currently includes 108 extant species, 26 subspecies and 2 fossil species, distributed worldwide, but reaches its highest diversity in tropics (LaPolla et al. 2010, AntWeb 2014b). In India, prior to this study *Nylanderia* was represented by eight species (AntWeb 2014a).

LaPolla et al. (2011a) discussed the systematics and biology of *Nylanderia* in a global context. As a part of world monographic series addressing the species-level taxonomy of

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the ant genus *Nylanderia*, LaPolla et al. (2011b) revised this genus from Afrotropics whereas Kallal and LaPolla (2012) revised the Nearctic *Nylanderia*. While the majority of regions are awaiting taxonomic revision, most of the work prior to 2010 is under *Paratrechina*. Significant taxonomic contributions to this genus from Southeast Asia include, Morisita et al. (1991), Wu and Wang (1995), Terayama (1999), Zhou (2001). In India, Bingham (1903) is the only taxonomic work on *Nylanderia*.

Here we describe the hitherto unknown worker caste of *Nylanderia smythiesii* (Forel, 1894) collected in foothills of Northwest Himalaya, the Shivalik range. Due to inadequate description and unavailability of type material, status of *Nylanderia assimilis* (Jerdon, 1851) seems doubtful and is considered a *species inquirenda* to minimize confusion by eliminating future use of this name. We also, provide a key to known species of *Nylanderia* from India; however, *Nylanderia aseta* (Forel, 1902) is excluded from the key as it will be transferred to *Paraparatrechina* (Bharti and Wachkoo, in prep.).

Materials and methods

The specimens were collected through Winkler's extractor, pitfall, honey bait, beating vegetation, soil core and hand picking methods. The taxonomic study was conducted on a Nikon SMZ 1500 stereomicroscope. For digital images, MP evolution digital camera was used on the same microscope with Auto-Montage (Syncroscopy, Division of Synoptics, Ltd.) software. Later, images were cleaned with Adobe Photoshop CS5. Specimens are deposited in PUPAC, Punjabi University Patiala Ant Collection, Patiala. Some worker specimens will be deposited in BMNH, Natural History Museum, London, U.K. and CASC, California Academy of Sciences, San Francisco, United States of America. Morphological terminology for measurements (given in millimeters) and indices include:

HL – Maximum length of head in full-face view, measured in straight line from the anterior most point of the median clypeal margin to a line drawn across the posterior margin from its highest points (to accommodate species where the posterior margin is concave).

HW – Maximum width of head in full-face view (excluding the portion of eyes that extends past the lateral margins of the head).

EL – Maximum length of eye as measured normally in oblique view of the head to show full surface of eye.

SL – Maximum length of the scape excluding the basal neck and condyle.

PW – Maximum width of the pronotum in dorsal view.

WL – Weber's length measured from the anterior surface of the pronotum proper (excluding the collar) to the posteriormost point of the propodeal lobes.

PrFL – Maximum length of the profemur from its margin with the trochanter to its margin with the tibia.

PrFW – Maximum width of the profemur.

CI – Cephalic index: HW/HL × 100.

SI – Scape index: SL/HW × 100.

REL – Relative eye length index: EL/HL × 100.

Taxon treatments

Nylanderia smythiesii (Forel, 1894)

Nomenclature

Prenolepis smythiesii Forel, 1894 – Forel 1894: 410, fig. 5 (q.m.) INDIA. Combination in *Paratrechina* (*Nylanderia*): Emery 1925: 220; in *Nylanderia*: LaPolla et al. 2010: 127.

Materials

Syntype:

a. country: India; stateProvince: Uttarakhand; verbatimLocality: Dehradun; individualCount: 1; sex: queen; recordedBy: A. Forel; institutionCode: MHNG, Geneva, Switzerland; collectionCode: CASENT0911010

Other materials:

a. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Andretta; verbatimElevation: 930 m; decimalLatitude: 32.0744; decimalLongitude: 76.5856; eventDate: Jun-21-2010; individualCount: 13; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

b. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Baijnath; verbatimElevation: 1125 m; decimalLatitude: 32.0527; decimalLongitude: 76.6500; eventDate: Jun-17-2010; individualCount: 110; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

c. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Bakhra; verbatimElevation: 650 m; decimalLatitude: 31.4087; decimalLongitude: 76.4327; eventDate: Oct-07-2008; individualCount: 1; sex: worker; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

d. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Bilaspur; verbatimElevation: 520 m; decimalLatitude: 31.3423; decimalLongitude: 76.7616; eventDate: Jul-01-2010; individualCount: 99; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

e. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Chanaur; verbatimElevation: 600 m; decimalLatitude: 31.9067; decimalLongitude: 76.1428; eventDate: Oct-20-2008; individualCount: 204; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

f. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Chohal; verbatimElevation: 450 m; decimalLatitude: 31.6666; decimalLongitude: 76.0666; eventDate: Oct-08-2008; individualCount: 1; sex: worker; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

g. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Kotla; verbatimElevation: 500 m; decimalLatitude: 31.8821; decimalLongitude: 75.9963; eventDate: Nov-30-2009; individualCount: 19; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

h. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Kotla; verbatimElevation: 500 m; decimalLatitude: 31.8821; decimalLongitude: 75.9963; eventDate: Jul-13-2010; individualCount: 9; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

i. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Lwasa; verbatimElevation: 1200 m; decimalLatitude: 30.7394; decimalLongitude: 77.1528; eventDate: Aug-27-2009; individualCount: 20; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

j. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Nagabari; verbatimElevation: 420 m; decimalLatitude: 32.3004; decimalLongitude: 75.8901; eventDate: Jun-18-2009; individualCount: 6; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

k. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Nahan; verbatimElevation: 760 m; decimalLatitude: 30.5596; decimalLongitude: 77.2960; eventDate: Sep-27-2009; individualCount: 3; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

l. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Poanta Sahib; verbatimElevation: 420 m; decimalLatitude: 30.4384; decimalLongitude: 77.6239; eventDate: May-09-2009; individualCount: 216; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

m. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Poanta Sahib; verbatimElevation: 420 m; decimalLatitude: 30.4384; decimalLongitude: 77.6239; eventDate: Aug-19-2009; individualCount: 171; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

n. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Renuka; verbatimElevation: 600 m; decimalLatitude: 30.6083; decimalLongitude: 77.4615; eventDate: Aug-26-2009; individualCount: 8; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

o. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Terrace; verbatimElevation: 430 m; decimalLatitude: 31.9234; decimalLongitude: 75.9294; eventDate: Jun-13-2009; individualCount: 5; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

p. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Terrace; verbatimElevation: 430 m; decimalLatitude: 31.9234; decimalLongitude: 75.9294; eventDate: Sep-24-2009; individualCount: 2; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

q. country: India; stateProvince: Himachal Pradesh; verbatimLocality: Terrace; verbatimElevation: 430 m; decimalLatitude: 31.9234; decimalLongitude: 75.9294; eventDate: Jul-19-2010; individualCount: 4; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

r. country: India; stateProvince: Jammu and Kashmir; verbatimLocality: Mansar; verbatimElevation: 690 m; decimalLatitude: 32.6979; decimalLongitude: 75.1489;

eventDate: Jul-13-2009; individualCount: 3; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

s. country: India; stateProvince: Jammu and Kashmir; verbatimLocality: Surinsar; verbatimElevation: 700 m; decimalLatitude: 32.7009; decimalLongitude: 75.1512; eventDate: Jul-14-2009; individualCount: 12; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

t. country: India; stateProvince: Uttarakhand; verbatimLocality: Assan Barrage; verbatimElevation: 750 m; decimalLatitude: 30.4417; decimalLongitude: 77.6754; eventDate: Jun-30-2010; individualCount: 204; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

u. country: India; stateProvince: Uttarakhand; verbatimLocality: Dakpathar; verbatimElevation: 750 m; decimalLatitude: 30.5164; decimalLongitude: 77.7848; eventDate: Aug-20-2009; individualCount: 11; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

v. country: India; stateProvince: Uttarakhand; verbatimLocality: Forest Research Institute, Dehradun; verbatimElevation: 640 m; decimalLatitude: 30.3416; decimalLongitude: 77.9903; eventDate: Sep-30-2008; individualCount: 12; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

w. country: India; stateProvince: Uttarakhand; verbatimLocality: Forest Research Institute, Dehradun; verbatimElevation: 640 m; decimalLatitude: 30.3416; decimalLongitude: 77.9903; eventDate: Oct-02-2008; individualCount: 1; sex: worker; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

x. country: India; stateProvince: Uttarakhand; verbatimLocality: Forest Research Institute, Dehradun; verbatimElevation: 640 m; decimalLatitude: 30.3416; decimalLongitude: 77.9903; eventDate: Jul-31-2009; individualCount: 16; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

y. country: India; stateProvince: Uttarakhand; verbatimLocality: Rajaji Forest Area, Dehradun; verbatimElevation: 660 m; decimalLatitude: 30.2483; decimalLongitude: 77.9878; eventDate: Aug-05-2009; individualCount: 5; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

z. country: India; stateProvince: Uttarakhand; verbatimLocality: Rajaji Forest Area, Dehradun; verbatimElevation: 660 m; decimalLatitude: 30.2483; decimalLongitude: 77.9878; eventDate: Aug-05-2009; individualCount: 1; sex: queen; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

aa. country: India; stateProvince: Uttarakhand; verbatimLocality: Rajaji Forest Area, Dehradun; verbatimElevation: 660 m; decimalLatitude: 30.2483; decimalLongitude: 77.9878; eventDate: Aug-05-2009; individualCount: 9; sex: males; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

ab. country: India; stateProvince: Uttarakhand; verbatimLocality: Rajaji Forest Area, Dehradun; verbatimElevation: 660 m; decimalLatitude: 30.2483; decimalLongitude: 77.9878; eventDate: Aug-11-2009; individualCount: 21; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

ac. country: India; stateProvince: Uttarakhand; verbatimLocality: Rajaji Forest Area, Dehradun; verbatimElevation: 660 m; decimalLatitude: 30.2483; decimalLongitude: 77.9878; eventDate: Sep-07-2010; individualCount: 18; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

ad. country: India; stateProvince: Uttarakhand; verbatimLocality: Selaqui, Dehradun; verbatimElevation: 670 m; decimalLatitude: 30.3720; decimalLongitude: 77.8605; eventDate: Aug-08-2009; individualCount: 7; sex: workers; recordedBy: Aijaz A. Wachkoo; institutionCode: PUPAC

Description

Worker (Fig. 1).

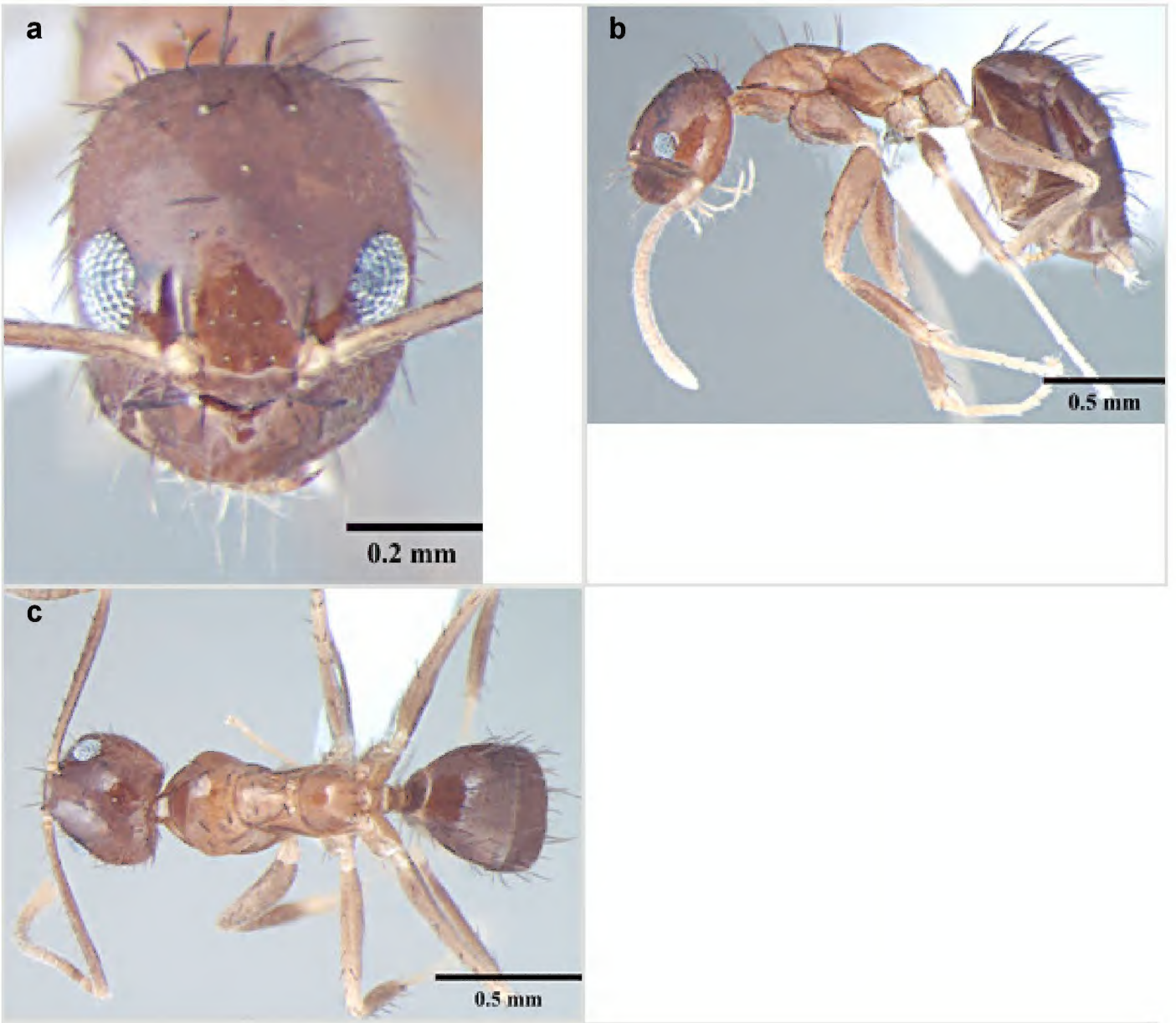

Figure 1.

Nylanderia smythiesii (Forel, 1894)

a: Worker Head, full face view
b: Worker Body, lateral view
c: Worker Body, dorsal view

Measurements: HL 0.60–0.68; HW 0.47–0.56; EL 0.14–0.19; SL 0.70–0.77; PW 0.37–0.43; PrFL 0.56–0.64; PrFW 0.13–0.17; WL 0.73–0.88. Indices: CI 77.68–82.26; SI 137.25–151.16; REL 23.64–27.42 (n = 8).

Head broadly oval; distinctly longer than wide, slightly wider posteriorly, lateral margins convex, posterior margin shallowly concave to gently convex with rounded posterolateral corners. Clypeus subcarinate in the middle; anterior clypeal margin weakly concave. Mandibles with six teeth. Eyes oval, weakly convex, covering one-third of lateral cephalic margin; three small ocelli present. Antennae long, scapes surpass the posterior margin by two-fifths their length.

Metanotal groove strongly developed, in lateral view interrupts the regular promesonotal convexity from propodeum; metanotal area long. Dorsal face of propodeal not higher than remainder of the notum, gently rounded; declivity steep.

In lateral view, petiole triangular with dorsum of the petiole well below the dorsum of propodeum, rounded above with posterior face much longer than anterior face.

Overall cuticle very smooth and shiny. Pubescence on body very sparse; almost entirely absent. Scapes and legs covered with abundant erect setae, and a very fine layer of pubescence. Erect setae of varying length cover head, pronotum, mesonotum and gaster. Setae very densely spaced on head and gaster.

Head brown; gaster brown to black; mesosoma, antennae and legs yellowish brown.

Queen (Fig. 2).

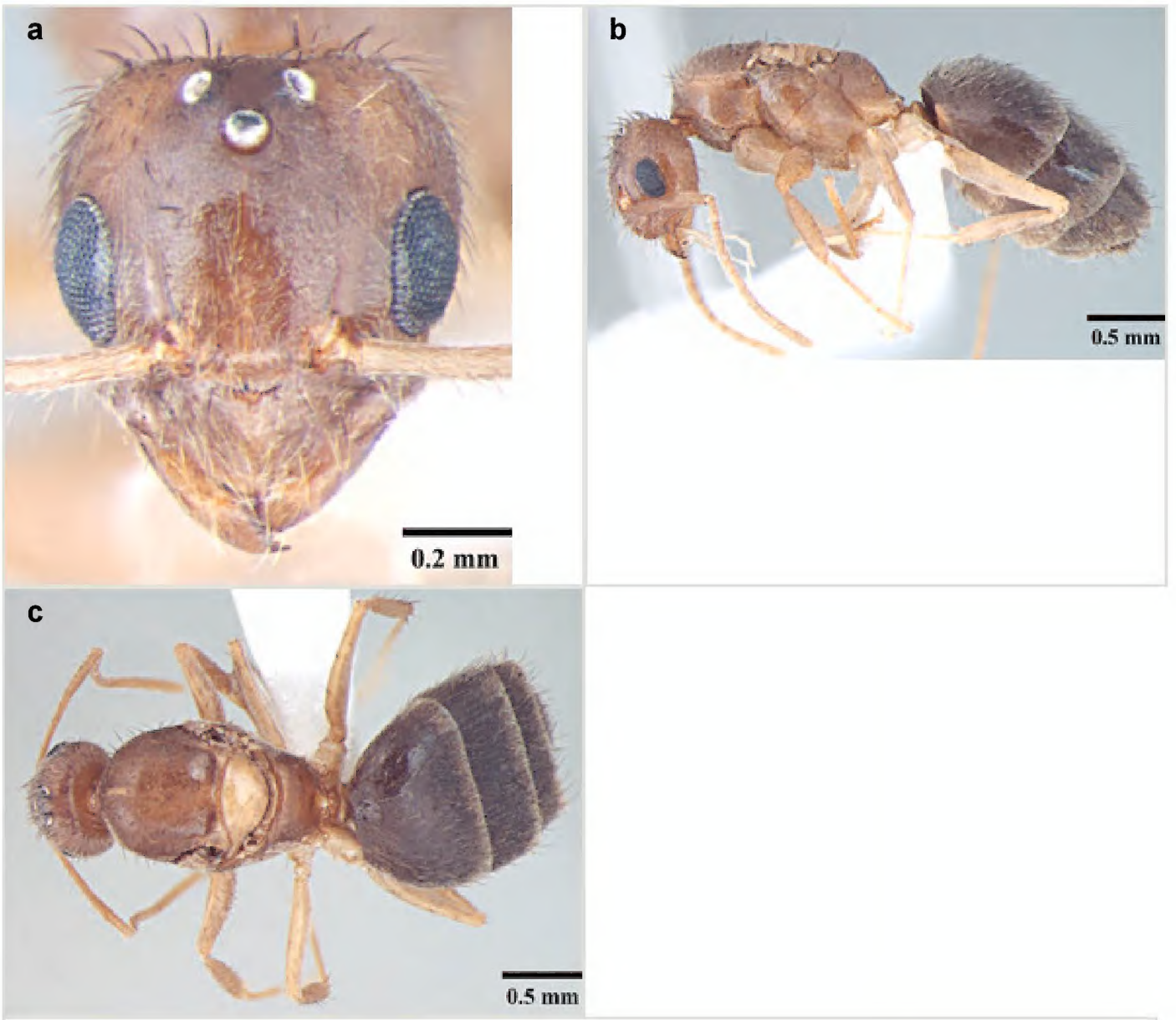

Figure 2.

Nylanderia smythiesii (Forel, 1894)

a: Queen Head, full face view
b: Queen Body, lateral view
c: Queen Body, dorsal view

Measurements: HL 0.84; HW 0.80; EL 0.30; SL 0.93; PrFL 0.82; PrFW 0.23; WL 0.88. Indices: CI 95.59; SI 115.82; REL 35.71 (n = 1).

Generally matches worker description, with modifications expected for caste and the following differences: Body covered with dense pubescence and fine punctulae. Head subtriangular, posterior margin concave; in lateral view, petiole with flat dorsum. Head yellow brown, gaster brown, a shade lighter than in workers.

Male (Fig. 3).

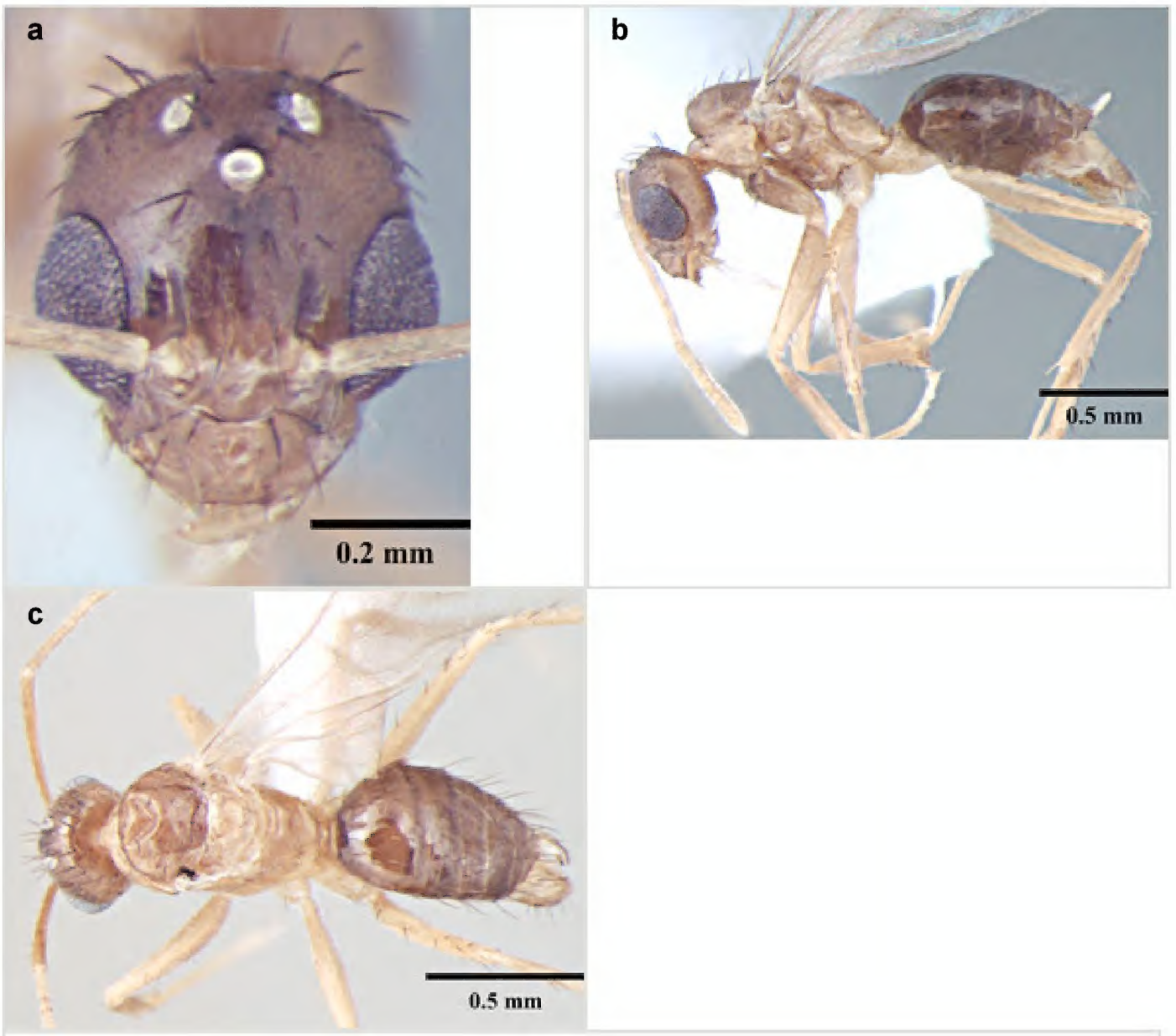

Figure 3.

Nylanderia smythiesii (Forel, 1894)

a: Male Head, full face view
b: Male Body, lateral view
c: Male Body, dorsal view

Measurements: HL 0.52–0.55; HW 0.42–0.46; EL 0.22–0.24; SL 0.66–0.72; PrFL 0.56–0.62; PrFW 0.13–0.15; WL 0.75–0.85. Indices: CI 80.00–85.42; SI 146.34–157.89; REL 41.67–44.44 (n = 8).

Head broadly oval; longer than wide; eyes large, subglobulose, projecting beyond head outline in full-face view; three prominent ocelli present. Antennae 13 segmented, filiform, scapes long, surpass posterior margin by about half their length. Mandibles slender, curved strap like with prominent, pointed apical and a small preapical tooth, remainder of masticatory margin smooth, without any teeth or denticles. Basal angle rounded, indistinct and seamlessly blends into inner mandibular margin.

Mesosoma enlarged to accommodate flight muscles; in lateral view scutum and scutellum flat; propodeum indistinct, lower than remainder of notum with very short dorsal face and long declivitous face.

Petiole as in worker; gaster elongated.

Parameres paddle-shaped, rounded apically, turning strongly inward toward midline of body posteriorly, as long as digiti; long setae extending off of parameres. Cuspi long and tubular reaching digiti dorsally; bent toward digiti; digiti weakly anvil-shaped; directed upward and covered with short peg-like teeth; digiti visible in lateral view. Penis valves projecting barely past parameres.

Sculpture, vestiture and color as in worker caste.

Distribution

This species is general in distribution in low altitude areas of Northwest India. Nests can be found easily underneath stones and leaf litter whilst foraging workers are fairly frequent on trees and fallen trunks.

Notes

The worker caste of this species is described here for the very first time and can be easily distinguished by the oval shape of head, and smooth and shiny cuticle without any pubescence. *Nylanderia smythiesii* although, abundant in its type locality, the Shivalik range of Northwest Himalaya, its worker caste was undescribed to date. Type locality, images of syntype queen examined on AntWeb (www.antweb.org): CASENT0911010, the description of female and male castes and the line drawings of external genitalia by Forel (1894) are all in conformity with our specimens and therefore, render us reasonable to describe its worker caste.

Nylanderia assimilis (Jerdon, 1851)

Nomenclature

Formica assimilis Jerdon, 1851 – Jerdon 1851: 125 (w.) INDIA. Combination in *Prenolepis*: Dalla Torre 1893: 177; in *Paratrechina* (*Nylanderia*): Emery 1925: 219; in *Nylanderia*: LaPolla et al. 2010: 127. **Species inquirenda**

Notes

The original descriptions is exceedingly inadequate and very little is known about the collection of Jerdon. Dalla Torre (1893) transferred it from *Formica* to *Prenolepis,* possibly because the body size, presence of large eyes and scattered white hairs all over the body mentioned in description mostly match the generic diagnosis of *Prenolepis*; subsequently Emery (1925) by implication transferred it to *Nylanderia*. Most of the taxa by Jerdon are invalid and have been synonymized or treated as *incertae sedis*. From the original description it could easily be argued that *Nylanderia assimilis* is yet another synonym of *Paratrechina longicornis* (Latreille, 1802), as the combination of characters mentioned by Jerdon (1851): large eyes, white hairs, body color and size are present only in *Paratrechina longicornis* of *Prenolepis* genus group from India. Moreover, Jerdon (1851) mentions it to be a frequent visitor of flowers, which also agrees with opportunistic feeding behavior of *Paratrechina longicornis*. Further, a Ph.D. thesis has been done on Formicidae of Malabar, India, the type locality of *Nylanderia assimilis*, but it could not be found. Bingham (1903) also excluded it from his study. Therefore, authors argue for its doubtful status and consider it *species inquirenda*.

Identification keys

Key to Indian species of *Nylanderia* (workers)

1	Head and mesosomal dorsum covered with a dense network of microreticulate sculpture	***N. birmana* (Forel)**
–	Head and mesosomal dorsum not microreticulate, either smooth or covered with fine punctulae	2
2	Gastral dorsum without a layer of pubescence underneath erect setae	***N. smythiesii* (Forel)**
–	Gastral dorsum with a layer of pubescence underneath erect setae	3
3	Head oval; scapes relatively shorter, surpass posterior margin of head by ≤ 1/3rd their length	***N. taylori* (Forel)**
–	Head subquadrate; scapes long, surpass posterior margin of head by ≥ 2/5th their length	4
4	Compound eye small, distinctly < 1/3rd the length of lateral cephalic margin	***N. indica* (Forel)**
–	Compound eye large, ≥ 1/3rd the length of lateral cephalic margin	5

5	Body unicolorous brown to black	***N. bourbonica* (Forel)**
–	Body distinctly bicoloured, with yellow brown to reddish brown mesosoma, and darker brown gaster	***N. yerburyi* (Forel)**

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Author contributions

Equally contributed.

References

- AntWeb (2014a) Bolton World Catalog. Release date: 2014 6 27. URL: http://www.antweb.org/images.do?subfamily=formicinae&genus=nylanderia&rank=genus&project=indiaants
- AntWeb (2014b) Bolton World Catalog. Release date: 2014 6 27. URL: http://www.antweb.org//description.do?genus=nylanderia&rank=genus&project=worldants
- Bingham CT (1903) The fauna of British India, including Ceylon and Burma. Hymenoptera. Ants and Cuckoo-Wasps. 2. Taylor and Francis, London, 506 pp.
- Dalla Torre CG (1893) Catalogus Hymenopterorum, hucusque descriptorum systematicus et synonymicus 7. Lipsiae, 289 pp.
- Emery C (1925) Hymenoptera. Fam. Formicidae. Subfam. Formicinae. Genera Insectorum 183: 1-302.
- Forel A (1894) Les formicides de l'Empire des Indes et de Ceylan. Part 4. Journal of the Bombay Natural History Society 8: 396-420.
- Jerdon TC (1851) A catalogue of the species of ants found in southern India. Madras Journal of Literature and Science 17: 103-127.
- Kallal RJ, LaPolla JS (2012) Monograph of *Nylanderia* (Hymenoptera: Formicidae) of the World, Part II: Nylanderia in the Nearctic. Zootaxa 3508: 1-64.
- LaPolla JS, Brady SG, Shattuck SO (2010) Phylogeny and taxonomy of the *Prenolepis* genus-group of ants (Hymenoptera: Formicidae). Systematic Entomology 35: 118-131. DOI: 10.1111/j.1365-3113.2009.00492.x
- LaPolla JS, Brady SG, Shattuck SO (2011a) Monograph of *Nylanderia* of the world: an introduction to the systematics and biology of the genus. Zootaxa 3110: 1-9.
- LaPolla JS, Hawkes PG, Fisher BL (2011b) Monograph of *Nylanderia* of the world, part1: Nylanderia in the Afrotropics. Zootaxa 3110: 10-36.

- Morisita M, Kubota M, Onoyama K, Ogata K, Terayama M, Yamauchi K, Sonobe R, Kondoh M, Imai HT (1991) A guide for the identification of Japanese ants. 2. Dolichoderinae and Formicinae. Myrmecological Society of Japan, Tokyo, 56 pp.
- Terayama M (1999) Taxonomic studies of the Japanese Formicidae. Part 5. Genus *Paratrechina* Motschoulsky. Memoirs of the Myrmecological Society of Japan 1: 49-64.
- Wu J, Wang C (1995) The Ants of China. China Forestry Publishing House, Beijing, 214 pp.
- Zhou S (2001) Ants of Guangxi. Guangxi Normal University Press, Guilin, China, 255 pp.